

## UNCLASSIFIED

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>					
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	28185	36521	33761	34654	36860	38050	40697	Continuing	Continuing
AH18 Artillery & Combat Support Technology	10789	14561	12230	13043	13879	15013	15193	Continuing	Continuing
AH19 Close Combat Weaponry	8425	11365	11019	10818	10538	10496	12329	Continuing	Continuing
AH28 Munitions Technology	8971	10595	10512	10793	12443	12541	13175	Continuing	Continuing
<p><b>A. Mission Description and Budget Item Justification:</b> Technologies being pursued in this Program Element (PE) will enable weapons and munitions to be more affordable, smaller and/or lighter (thus addressing their logistics burden) while maintaining or increasing their lethal effects. The PE funds technologies to provide tank main armament upgrade opportunities for fielded and future ground combat systems, precision and extended range munitions, and alternative defeat mechanisms for advanced artillery, mortars, area denial and armor systems for the Army after 2010 and Future Combat Systems (FCS) enabling technologies. The PE funds modeling and analytic codes for thermal analysis and high impetus low flame temperature propellants to reduce wear on gun tubes (which degrades accuracy and increases the system cost); high energy explosive technologies that increase projectile and warhead lethality; advanced smaller, lighter more effective shaped charge and explosively formed penetrator (EFP) warheads; advanced armament fire control, and decision aids and software architecture; advanced acoustic sensor technology to enhance performance of smart munitions, technology advances in acoustic sensors and anti-armor anti-personnel area denial systems, and smart materials to improve accuracy and reduce operational and support (O&amp;S) costs. This PE also includes work on thermal management of high performance, high rate of fire, large caliber guns, and advanced air-to-air guns in enhanced rotary wing aircraft (e.g., Apache and Comanche) armaments, as well as ways to make artillery systems more flexible and deployable through range extension and weight reduction technologies. The work in this PE is consistent with the Army after 2010, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. The U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ primarily manages this program. Work in this PE is related to, and fully coordinated with, efforts in PE 0602618A (Ballistics Technology), PE 0602623A (Joint Service Small Arms Program (JSSAP)), and transitions to work performed in PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603607A (JSSAP) and PE 0603802A (Weapons and Munitions Advanced Development).</p>									
<i>Page 1 of 9 Pages</i>					Exhibit R-2 (PE 0602624A)				

## UNCLASSIFIED

## ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

DATE  
February 2000

BUDGET ACTIVITY

**2 - Applied Research**

PE NUMBER AND TITLE

**0602624A Weapons and Munitions Technology**

<b>B. Program Change Summary</b>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (FY <u>2000 / 2001</u> PB)	28913	34687	37487
Appropriated Value	29189	36687	
Adjustments to Appropriated Value			
a. Congressional General Reductions	-276		
b. SBIR/STTR	-481		
c. Omnibus or Other Above Threshold Reductions		-78	
d. Below Threshold Reprogramming	-131		
e. Rescissions	-116	-88	
Adjustments to Budget Years Since (FY <u>2000 / 2001</u> PB)			-3726
Current Budget Submit (FY <u>2001</u> PB)	28185	36521	33761

Change Summary Explanation: Funding – FY 2001: Funds reprogrammed (-3726) for higher priority requirements.

UNCLASSIFIED

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>				PROJECT <b>AH18</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH18 Artillery & Combat Support Technology	10789	14561	12230	13043	13879	15013	15193	Continuing	Continuing

**Mission Description and Justification:** This project focuses on the exploratory development of technology for cannon artillery, mortar weapon, fire control and combat support systems in support of the Army after 2010. Also being pursued are technologies for improving combat vehicle lethality and fire control while reducing life cycle costs with innovative applications of smart materials, advanced actuators, advanced digital stabilization and micro-electro-mechanical systems (MEMS) technology for embedded fire control sensors. Decision aid software technology is being developed to increase battlefield survivability of self-propelled howitzers, along with technologies for improving the effectiveness and affordability of next generation smart munitions. Meteorological extraction algorithms are also being developed to further improve artillery accuracy. Technology for artillery projectile rotating and obturating bands is being pursued to address cannon wear for high performance weapons. Recoil management and lightweight materials technologies are being developed to create a more lethal, yet lightweight Future Direct Support Weapon System (FDSWS). The objective of the FDSWS is to provide 155mm lethality with 105mm deployability in a 5000Lb towed howitzer, air transportable by a UH60 helicopter and towed by a heavy Highly Mobile Multi-Wheeled Vehicle (HMMWV). The application of light-weight, high-strength composites to mortar projectiles is being pursued to significantly extend range while providing increased lethal effectiveness, such as the Extended Range Mortar Cartridge (ERMC) program. This project also supports the development and evaluation of advanced area denial concepts as an alternative to current anti-vehicle/anti-personnel mining techniques. This project also funds technology to develop advanced acoustic sensors which will provide non-line of sight target queuing for a variety of weapons platforms. Technologies for reducing artillery target location error and providing real time targeting and battle damage assessment data to fire direction centers are also being developed to support information dominance strategies for the Army after 2010. Development of the Distributed Interactive Fire Mission (DIFM) software supports the Army after 2010 fire control systems. This software will enable groups of tanks, fighting vehicles, attack helicopters, etc. to fight in unison by coordinating their fires against targets; substantially improving battlefield survivability and operations tempo. Targets will be automatically assigned to individual shooters based on the most effective pattern to ensure rapid first-shot execution and progression to the next target assignment. QuickLook provides the brigade commander with real time target imagery, coordinates, and battle damage assessment (BDA). This system will utilize an artillery launched loitering munition that flies out to a maximum range of 50 km. and acquires and transmits targeting information (i.e., video, Global Positioning System (GPS)) back to the tactical operations center via a wireless link.

**FY 1999 Accomplishments:**

- 3500 - Fabricated a cannon for ultra lightweight 155mm FDSWS and modified soft recoil test bed; developed concepts for 5700 lb. ER fluid-controlled soft recoil weapon; designed upper carriage and tipping parts for testbed.  
- Gathered area denial intrusion sensor data in various terrain and weather conditions; developed computer algorithms; conducted simulation to evaluate operational effectiveness.
- 3347 - Developed a network accessible reference architecture data repository of reusable fire mission components; completed a baseline reusable voice natural language interface component for fire missions; developed process tools to support a "software component factory" approach to affordable embedded software development; this effort supports the Army after 2010 information dominance strategies.

Project AH18 Page 3 of 9 Pages Exhibit R-2A (PE 0602624A)

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>	PROJECT <b>AH18</b>
<p><b>FY 1999 Accomplishments: (continued)</b></p> <ul style="list-style-type: none"> <li>- Completed implementation and battle lab evaluation of Technical Architecture-compliant fire mission and movement planning decision aid for an artillery chief-of-section.</li> <li>- Completed capture of armament decision aid knowledge base; completed hardware, software and distributed interactive simulation integration efforts; tested and verified operation of new decision aid components; conducted man-in-the-loop testing.</li> <li>- Analyzed and applied results of the DIFM Concept Experimentation Program conducted by the Mounted Maneuver Battle Space Battle Lab, which will develop multi-shooter long range armored fighting vehicle battle scenarios for DIFM simulations.</li> <li>• 2372 - Fabricated prototype components of weapons systems using smart materials and structures technology to significantly improve functionality, reduce size/costs/weight and improve or maintain existing lethality.</li> <li>- Established preliminary concepts and conducted preliminary analyses of novel indirect fire systems.</li> <li>- Developed prototype environmental characterization, propagation prediction, and artificial intelligence rule-based sensor deployment algorithms; completed integration of environmental sensors (e.g., temperature and wind) with an acoustic sensor package; conducted field test.</li> <li>- Fabricated test hardware and lightweight rocket motor for ERMIC; conducted interior ballistics tests; performed combat utility simulations.</li> <li>• 1570 - Developed tactical targeting and battle damage assessment munition (i.e. QuickLook) operational architecture and procedures; performed studies on battlefield payoffs, target location, logistics, communication architecture and system design concept; developed system design.</li> <li>- Developed retrofit obturator to improve projectile accuracy and minimize cannon wear for extended range weapon systems; conducted subscale testing of advanced polymer materials for obturator application.</li> </ul> <p>Total 10789</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 5572 - Fabricate hardware and conduct preliminary tower/captive flight tests to validate common aperture laser radar infrared (LADAR/IR) sensor performance against low observable targets; fabricate prototype sensor hardware for gun-hardening experiments.</li> <li>- Conduct field test of prototype area denial hardware; evaluate weapons system and sensor performance; investigate alternative delivery and recovery methods.</li> <li>- Execute ER fluid research which includes fluid characterization software control methodology, material and structures modeling, and power supply design; start validation of virtual simulations through hardware designs.</li> <li>• 4172 - Extend the fire mission and movement planning decision aid to a fully Technical Architecture compliant suite of decision aid components to support sustainment, situational awareness and mission rehearsal for an artillery chief-of-section; establish a baseline decision aids application software component reuse library and link with specification data library to support follow-on software component factory technology.</li> </ul>		
Project AH18	Page 4 of 9 Pages	Exhibit R-2A (PE 0602624A)

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>	PROJECT <b>AH18</b>
<ul style="list-style-type: none"> <li>- Develop DIFM multi-shooter vs. multi-target algorithms.</li> <li>- Develop an effective windscreen and vehicle self-noise cancellation algorithm/software for Striker (HMMWV platform); develop acoustic/seismic propagation models and relate performance to potential gains in cost and operational effectiveness of a sensor network.</li> </ul>		
<b>FY 2000 Planned Program: (continued)</b>		
• 4604	- Fabricate QuickLook artillery fired loitering munition reconnaissance system hardware components and perform sub-system testing.	
	- Complete ERMIC rocket motor static testing; update interior and exterior ballistic models; conduct composite motor and fin assembly structural integrity test; conduct live-fire mass simulated range test.	
• 213	- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.	
Total	14561	
<b>FY 2001 Planned Program:</b>		
• 4508	- Conduct system trade-off studies, fabricate sensor hardware and perform captive flight tests on alternate sensor designs with a common aperture LADAR/IR transducer for detection of low observables.	
	- Perform developmental and operational testing of 5700 lb FDSWS testbed to assess stability, precision and accuracy to validate virtual simulations.	
	- Further identify and develop critical technologies; update and mature modeling and simulations; pursue evaluation of ER recoil management, isogrids and load out of battery technologies.	
	- Conduct integrated Area Denial System experiment.	
• 3414	- Complete implementation and feasibility demonstration of an architecture-based software component factory process for rapid generation of embedded fire mission application software.	
	- Complete DIFM multi-shooter algorithms development; analyze and optimize DIFM using Distributed Interactive Simulation; quantify DIFM multi-agent performance.	
	- Fabricate prototype hardware and conduct full-up range flight test of the ERMIC.	
• 4308	- Integrate QuickLook system components and perform integrated captive flight test.	
	- Exhibit improved cannon wear life (Crusader) in wear testing; verify design improvements for stockpiled ammunition.	
	- Collect launch signatures on Multiple Launch Rocket System (MLRS) and mortars and add data to expand detection capability; demonstrate modeling and target location and tracking capabilities against non-real time data and assess improvements in operational effectiveness; initiate development of advanced detection, classification and tracking algorithms.	
Total	12230	
<div>Project AH18</div> <div align="center">Page 5 of 9 Pages</div> <div align="right">Exhibit R-2A (PE 0602624A)</div>		

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>				PROJECT <b>AH19</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH19 Close Combat Weaponry	8425	11365	11019	10818	10538	10496	12329	Continuing	Continuing

**Mission Description and Justification:** The objective of this project is to exploit and advance new technologies which will demonstrate significant improvements in direct fire weapon performance for ground and air combat vehicles. Principal efforts support the FCS Armament program funded in PE 0603004A. Included in this PE are technologies for tank projectile precursor defeat of explosive reactive armor (ERA), composite material enhancements for sabots and gun structures, trajectory correction areas of projectile design and fabrication, means to increase gun life by reducing barrel wear, thermal management of high rate launch mechanisms and munition autoloaders including feeders and storage mechanisms. This PE will develop multi-mode fuzing technologies to include lower cost self-destruct technologies for submunitions, which will reduce unexploded ordnance on the battlefield and low cost electronic safe and arm devices for single and future multi-mode warheads. The project also develops extended range munitions and alternative defeat mechanisms of advanced armor systems for the Army after 2010. This project provides opportunities for longer range, more accurate and more lethal cannon systems for armored vehicles to include enabling technologies to support FCS. The approach will be to develop both the hardware and analytical tools necessary to assess system performance, identify problem areas and to develop solutions.

**FY 1999 Accomplishments:**

- 5708 - Demonstrated kinetic energy (KE) radial thruster technology capability to measure and counter flight disturbances to enhance accuracy up to 70%; first thruster diversion test successfully completed; demonstrated MEMS accelerometer capability to measure KE disturbances through flight tests.
- Conducted analytical evaluation of extended range munition capabilities; completed three system design concepts; prepared for sensor demonstration tests with two candidate system concepts.
- Demonstrated novel penetration defeat of future threat complex armors; performed armor tests of novel penetrator concepts and then down-selected to the best candidate for integrated structural tests.
- 1738 - Completed system level trade-off analysis and developed concepts of a notional future combat vehicle armament system and a multi-role family of munitions.
- 979 - Completed adhesive test of sputter coated (tantalum) 25mm gun barrels.
- Total 8425

**FY 2000 Planned Program:**

- 1480 - Deposit tantalum coating by cylindrical magnetron sputtering process on test coupons, cylindrical sections and a full length 25mm gun barrel.
- 2274 - Conduct simulation of existing and conceptual target defeat techniques (i.e., Institute for Advanced Technology (IAT), (University of Texas); ARDEC; and Army Research Laboratory (ARL)) for medium caliber applications.

Project AH19 Exhibit R-2A (PE 0602624A)

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>	PROJECT <b>AH19</b>
<p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>• 2734 - Analyze, simulate and select lethality package of advanced propulsion system for FCS; complete conceptual design of a light weight, low recoil launcher (both 60% less than 120mm M256); demonstrate recoil mitigation and composite launcher components; develop/optimize advanced propulsion for higher energy/lower vulnerability; develop a notional concept for improved automation of weapon platforms.</li> <li>• 2619 - Establish target set vulnerabilities for three agile target effects systems: 1) dazzler munition using an acoustic/light source to render sensors ineffective for a limited time, 2) a pulsed laser generator for Unmanned Aerial Vehicles (UAV) and sensor suppression and 3) a flat panel multi-mega/gigawatt generator demonstrating neutralization of electronic/communications equipment. Complete the technology evaluation and trade-off studies for low cost course correction technologies, which will provide a dramatic increase in, hit probability at extended ranges, up to 400%.</li> <li>• 750 - Develop enhanced target defeat for medium caliber systems exploiting emerging technologies in composite sabots, novel penetrators, propulsion and bursting munitions.</li> <li>• 1100 - Develop lower cost self-destruct fuze technologies for application to DPICM, which will reduce unexploded ordnance on the battlefield.</li> <li>• 253 - Conduct laboratory testing of individual components to evaluate hardening and reliability requirements for a broad spectrum of low cost enhanced accuracy munitions.</li> <li>• 155 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 11365</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1500 - Use tantalum coating process to apply cannon bore coatings to medium (25mm) and large (120mm) caliber gun barrels and validate wear performance.</li> <li>• 2218 - Optimize power consumption and output to maximize target effects for laser and microwave anti-sensor devices.</li> <li>• 5461 - Complete fabrication of lightweight/low impulse launcher for FCS. - Determine feasibility of propulsion and launch system to launch a surrogate family of munitions at desired velocities.</li> <li>• 1140 - Develop low cost, universal electronic safe and arm (ESA) technology for missiles and smart munitions.</li> <li>• 700 - Develop enhanced target defeat mechanism of light armor targets using novel penetrators for increased penetration and behind armor effects.</li> </ul> <p>Total 11019</p>		
Project AH19	Page 7 of 9 Pages	Exhibit R-2A (PE 0602624A)

**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>2 - Applied Research</b>				PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>				PROJECT <b>AH28</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH28 Munitions Technology	8971	10595	10512	10793	12443	12541	13175	Continuing	Continuing

**Mission Description and Justification:** The objective of this project support advanced technologies in gun propellants with wear reducing additives, explosives, warheads, insensitive munitions (IM) and advanced materials for EFP and shaped charge (SC) warheads. Advances in warhead technology will provide improved EFP and SC warheads and advanced warhead liners to defeat and protect both current and future systems. High energy/density explosives are needed to increase lethality. New, improved energetic materials have numerous transition opportunities for weapons system upgrades. The integrated IM efforts conducted in this project will increase the survivability of tanks, artillery, helicopters and infantry fighting vehicles, as well as the safety in manufacturing plants, storage depots, and during air and sea transport. Development and analysis of EFP for active protection systems supports work performed under PE 0603005A. The technologies developed in this project support current FCS requirements.

**FY 1999 Accomplishments:**

- 3030 - Conducted static warhead tests using high power explosives to show an increase in energy up to 25%.
- 3027 - Defined baseline technology for a compact warhead for missile applications.
- 1834 - Conducted studies on the processibility of thermoplastic elastomers and the effect of binder/plasticizer type and ratio on energetic materials to provide higher energy, safer gun propellant; investigate additives to reduce gun tube wear.
- 1080 - Designed multiple explosively formed penetrator warhead for active protection against chemical energy and kinetic energy threats.
- Total 8971

**FY 2000 Planned Program:**

- 3080 - Manufacture laboratory scale quantities of next generation, more powerful explosive and conduct sensitivity evaluation.
- 3680 - Conduct testing of combined anti-armor/anti-bunker warheads.
- 1900 - Formulate and test CL-20 based advanced propellants.
- 1800 - Design/fabricate/test a multiple EFP warhead for active protection system (APS).
- 135 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.
- Total 10595

Project AH28
Page 8 of 9 Pages
Exhibit R-2A (PE 0602624A)



**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>2 - Applied Research</b>	PE NUMBER AND TITLE <b>0602624A Weapons and Munitions Technology</b>	PROJECT <b>AH28</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 3000 - Scale up and characterize next generation more powerful explosives.</li> <li>• 3800 - Develop compact/multiple effects warhead and design/optimize the co-linear explosively formed penetrator warhead.</li> <li>• 1912 - Develop significant propulsion performance increase in scaled and large caliber guns.</li> <li>• 1800 - Conduct dynamic tests of EFP warhead for active protection system against chemical and KE threats.</li> </ul> <p>Total 10512</p>		
<div>Project AH28</div> <div align="center">Page 9 of 9 Pages</div> <div align="right">Exhibit R-2A (PE 0602624A)</div>		